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PROPOSAL FOR A REGIONAL TUNA TAGGING PROGRAM

1. TITLE OF PROPOSAL

Regional tagging program for bigeye, skipjack, and yellowfin tuna in the eastern Pacific Ocean, 2010-2012

2. OBJECTIVE

The primary objective is to conduct large-scale tagging of the three main commercial species of tunas, bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), and yellowfin (*Thunnus albacares*), captured in the purse-seine and longline fisheries of the eastern Pacific Ocean (EPO). The data obtained would improve the scientific basis for estimation of the exploitation, movements, natural mortality, and growth rates of these species in the EPO.

3. BACKGROUND INFORMATION AND JUSTIFICATION

In the EPO, purse-seine catches of bigeye and skipjack tunas have increased substantially in the past decade (Anonymous, 2008). The rapid changes in the fishery have made it difficult to assess its effect on those stocks. Evaluations conducted in recent years (Anonymous, 2008; Hampton and Maunder, 2005) have shown the need for caution in managing this changed situation, but above all the need for better scientific information on which to base management decisions.

Purse-seine fisheries throughout the Pacific now focus a large proportion of their effort on tunas associated with drifting fish-aggregating devices (FADs), a mode of fishing that has evolved to become highly efficient for harvesting all three species of tunas (Fonteneau *et al.,* 2000). For scientists, it has created problems in calculating indices of species-specific catches per unit of effort for the purse-seine fishery, thus creating uncertainty in the indices of abundance and in the management recommendations for these species. This is partially a result of a lack of understanding of the characteristics and dynamics of the aggregations that are associated with FADs. The spatial and temporal dynamics of tunas within these aggregations should be thoroughly investigated in order to quantify several important life history characteristics of tunas, including movements, behavior, and vulnerability to fishing gear.

In the EPO, schools of tuna within large multi-species aggregations associated with FADs have been exploited by large purse-seine vessels since 1994 (Lennert-Cody and Hall, 2000; Anonymous, 2008), predominantly between 5°N and 15°S. The practice of deploying FADs and targeting the tunas that associate with them has increased over the past decade, and has contributed to a significant increase in the catch of bigeye, from an annual average of about 5 thousand metric tons during 1964-1993 to 46 thousand metric tons during 1996-2003, although the greatest component of the catch of this fishery is skipjack (Anonymous, 2008).

Bigeye tuna is the primary target species of the longline fleet fishing in the EPO. Longline catches of bigeye from the EPO have historically exceeded those from the western and central Pacific Ocean (WCPO), and the catches of bigeye from the Pacific have been greater than those from any other ocean (Anonymous, 2008).

The longline fishery targets medium to large bigeye, while the purse-seine fishery catches primarily small to medium bigeye. In the EPO, there is a reasonable concern that the purse-seine fishery is affecting the longline fishery, and that large catches of small bigeye have reduced the stock size and the sustainable

catches. The catches by the longline fishery have declined in recent years, from an annual average of about 86 thousand metric tons during 1986-1994 to about 51 thousand metric tons during 1995-2003 (Anonymous, 2008).

Knowledge of current levels of exploitation of bigeye, skipjack, and yellowfin tunas, as well as of their movements, natural mortality, and growth rates, are essential for stock assessments. Although stock assessments have been performed for these species in the EPO (Anonymous, 2008), there are uncertainties in some of the assumptions and parameter estimates. The proposed tagging program would provide a direct means for estimating these parameters, and valid estimates of these parameters would improve confidence in stock assessments, help quantify the degree of interaction between the purse-seine and the longline fisheries, and permit better management decisions. The current assessment of skipjack tuna is unreliable due to the unavailability of an index of stock abundance. Estimates of exploitation rate and abundance from the tagging program are therefore essential to produce a reliable stock assessment for this species. The bigeye tuna assessment is sensitive to the mean length at age assumed for large fish. Ageing using otoliths is problematic for large bigeye tuna, and growth rates estimated from the tagging program are needed. The assessments of all three species are sensitive to both the absolute level of natural mortality and the age-specific changes in natural mortality. Current values assumed for natural mortality are based on little information, and estimates from the tagging program are essential to provide more confidence in the current assessments. The stock assessments are currently conducted under the assumption that each species in the EPO comprises a single stock, and it is not known if different spatial scales are more appropriate for assessment and management. The tagging program will provide the information on movement that is required to evaluate the appropriate spatial scale for assessment and management.

Regional tuna-tagging projects conducted recently in the WCPO (Hampton and Gunn, 1998; Hampton and Williams, 2005), around the Hawaiian Islands (Itano and Holland, 2000), and in the EPO (Schaefer and Fuller, 2005a; Anonymous, 2007), have demonstrated that bigeye exhibit relatively restricted geographical movements, similar to those of yellowfin and skipjack, showing regional fidelity (Hunter *et al.,* 1986; Sibert and Hampton, 2003). However, investigations of the genetic basis of the population structure of these species, through analysis of mitochondrial DNA, could not reject the null hypothesis that each of these species shares a common gene pool (Scoles and Graves, 1993; Grewe and Hampton, 1998). Furthermore, there have not yet been any results from tagging of bigeye in the EPO near the management boundary that separates the EPO and the WCPO. Thus, the results of these two methods clearly indicate that there is a need to determine the levels of mixing among the stocks for inclusion in the regional assessments. Concurrent tagging in regions across the Pacific is probably the most practical and accurate method for obtaining this important information.

In addition to tagging the three species of tunas externally with conventional plastic dart tags, we propose to implant archival and acoustic tags in limited numbers of each of these species. Tuna movement paths reconstructed from recovered geolocating archival tags provide exceptional information on stock structure, movements, and mixing, complementing the information from conventional tag recoveries. The data on behavior and habitat utilization from archival tags is useful for habitat-based standardization of longline catch and effort data in stock assessments (Langley *et al*., 2005), and can most likely also be useful in the standardization of purse-seine catch and effort data. The archival tag data also provide resolution of residence times on both small and large scales, complementing the results of conventional tagging, and providing long-term information on geographical and spatial distributions (Gunn and Block, 2001; Schaefer and Fuller, 2002; Schaefer *et al*., 2007; Schaefer and Fuller, 2008). Research utilizing acoustic tags and ultrasonic telemetry would provide information on fine-scale behavioral differences between skipjack tuna and other species within aggregations associated with FADs, and may reveal opportunities for capturing skipjack without capturing bigeye, yellowfin, and other species of concern associated with FADs (Schaefer and Fuller, 2005b).

The proposed tagging program is in accordance with the general aspirations of the fisheries research

community, including the need to conduct regional research projects to achieve Pacific-wide goals. Scientists from regional research organizations throughout the Pacific Ocean attending the prioritization workshop of the Pelagic Fisheries Research Program at the University of Hawaii in November 2005 agreed that Pacific-wide tagging experiments are necessary to address many of the important scientific issues, including movements and mixing rates, surrounding bigeye and other primary market species of tunas. The IATTC scientific working group considers tagging experiments to be of high priority, and in October 2007 a workshop was convened entitled "Using Tagging Data for Fisheries Stock Assessment and Management." A regional tuna tagging program in the EPO was recently listed as the first recommendation in the report of the 9th IATTC Stock Assessment Review Meeting in May 2008.

The IATTC would welcome and encourage the participation of scientists from member governments and participating organizations in the at-sea work, data analyses, and reporting of results.

4. DESCRIPTION OF PROPOSED ACTIVITIES

We propose to conduct a series of tag-release experiments in the EPO over the 2010-2012 period, aiming to tag around 100,000 tunas with dart tags. Bigeye, skipjack, and yellowfin, of as great a size range as possible, would be targeted for tagging, with an intended distribution of approximately 40-20-40% among the three species. The primary tagging would be done aboard multiple live-bait pole-and-line vessels, with about 12 months total charter time per year, to enable adequate spatial and temporal tag deployments throughout the EPO. In addition, we would explore opportunities for using tuna purse-seine vessels for tagging during closures of the purse-seine fishery, under mutually beneficial agreements. The focus of tagging activities would include tunas associated with floating objects, seamounts, dolphins, and in unassociated surface schools.

We propose to conduct two 4-month-long experiments each year, two months apart, using chartered live-bait pole-and-line vessels to tag bigeye, skipjack, and yellowfin tunas throughout the range of the fisheries in the EPO. The tag releases would be distributed over the most appropriate areas and periods possible. We would also conduct about two months of tagging each year, focusing in coastal areas and near islands, between northern Mexico and Peru, also using live-bait pole-and-line vessels. Tunas associated with floating objects, including FADs, and with seamounts and dolphins, and in unassociated surface schools, would all be targeted for tagging.

Purse-seine vessels would also be considered for conducting opportunistic tagging cruises through mutually-beneficial agreements between owners and the IATTC. We plan to conduct two to four 6- to 8-week cruises per year aboard purse-seine vessels to tag bigeye, skipjack, and yellowfin tunas associated with FADs and dolphins, and in unassociated surface schools, throughout the central and western area of operations of the purse-seine fishery in the EPO. Methods that have been developed in recent years for holding purse-seine nets open in order to transfer tunas into towing pens would be modified for tagging tunas. The staff will explore with the member governments the possibility of carrying out such tagging work during fishery closures.

Double-tagging experiments, using dart tags, would be conducted by each tagger throughout the program, in order to estimate tag shedding rates. Tag seeding studies would be conducted throughout the program and simultaneously with the tagging experiments in order to estimate the recovery rates of recaptured tagged tunas. IATTC observers aboard purse-seine vessels could be used for the tag seeding studies through placing dart tags in tunas before they are frozen in the vessel's wells.

In addition to conventional plastic dart tags, archival tags would also be implanted in bigeye, skipjack, and yellowfin tunas. Archival tags would provide information on movements, behavior, and habitat utilization for the three species throughout the EPO. Because of the high rewards paid for recovered tags, the recovery rate of archival tags is expected to be essentially 100%, and can be used as a basis for an alternative estimate of exploitation rate that is free of recovery issues. We would deploy 75 archival tags per year each in bigeye, skipjack and yellowfin tunas. The archival tags would be implanted in the

peritoneal cavities of the fish; this method has been shown to result in little tag shedding, high survival, and high recovery rates. Evaluations would be conducted of the spatial and temporal variation in movements, behavior, and habitat, and of the effects of oceanographic features, including bathymetry, sea-surface temperatures, ocean color, fronts, and eddies.

We also propose to conduct observations and collect behavioral data on tuna aggregations associated with FADs, using a number of complementary scientific tools. Telemetry studies would employ an acoustic tracking system, in conjunction with coded acoustic tags implanted in the peritoneal cavities of bigeye, skipjack, and yellowfin tunas, to enable simultaneous data collection during trials of approximately 48 hours. These electronically-tagged tunas would act as markers within the aggregation, from which fine-scale spatio-temporal data can be collected. During each trial the relative orientation and movements of the tuna schools making up the aggregation would be monitored and evaluated with scanning sonar and echo-sounder imaging, from which digital images would be recorded. The sonar would be used for observing the aggregation's abundance, horizontal distribution, and behavior, and the multifrequency echo sounder to observe its vertical distribution, species composition, and behavior. In addition, an underwater video camera connected to a recording device would be suspended under the FAD, which would provide additional information on species identification and behavior.

Successful completion of the program would require a number of activities in addition to the actual fieldwork involving tagging of fish, including the following:

1. Securing recapture information on tagged fish, including data on location, date, and size. The requirements for this include: a) informing fishermen of the program, and its potential benefits for the fishery; b) paying adequate rewards for the return of tags, and establishing a lottery as an additional incentive; c) making it easy to return the tags by establishing a system by which the IATTC technicians who go aboard the vessels in port for various purposes, such as making abstracts of the logbooks, collect the tags and information and pay the rewards. The IATTC staff will collect as much data as possible, through its field offices and observer program, and will seek the cooperation of national fisheries authorities in recovering tags and associated information, particularly from longline catches.
2. Processing the information and entering it into a computerized database. The IATTC staff has previous experience with this process from earlier experiments, and in 2000 established a database in which the release and recapture data are stored; the data can be easily extracted for analyses.
3. Analysis of tag release and recapture information. This part of the program could be of interest to other organizations as well, and we would welcome collaboration in the analysis of the data.

5. REPORTING

The activities and results of the program would be routinely reported in the IATTC Quarterly and Annual Reports. Final results of various aspects of the program will be published in peer-reviewed journals, in a timely manner.

All funds would be used solely for the program, and any funds remaining on completion of the program will be reported to the donors and disposed of in accordance with their wishes. Financial accounting would be maintained in a manner that would allow complete transparency to donors, and will be identified in the IATTC's financial accounts.

6. FUNDING

The IATTC will commit scientific staff members for conducting tagging operations, and for the analyses of the data and the reporting of results. The IATTC will pay the costs of data collection in areas where the Commission has offices, and of data processing. The IATTC will also administer the reward program. In the budget we have assumed that the governments of nations from outside the region would be willing to pay the costs of data collection in areas not covered by IATTC staff. It is assumed that the costs for

scientists of other organizations who participate in field activities or in the analyses of the data would be borne by their respective organizations.

7. ANNUAL BUDGET

Funds are requested for the following annual budget for each of the three years (2010-2012):

Vessels		**US$**
Dedicated pole-and-line tagging vessel, captain, crew and all operational expenses	240 days @ $3,000/day	720,000
Dedicated pole-and-line tagging vessel, captain, crew and all operational expenses	120 days @ $2,000/day	240,000
Miscellaneous (port fees, etc)		15,000
Personnel		
Assistant scientists	2 @ $46,100/year	92,200
Sea pay		62,000
Equipment		
Dart tags	35,000 @ $0.60/ea	21,000
Archival tags	150 @ $850/ea	127,500
Archival tags	75 @ $1,000/ea	75,000
Acoustic tags	54 @ $600/ea	32,400
Satellite buoys for FADs		54,000
Miscellaneous		15,000
Rewards		
Dart tags (bigeye)	40% recovery @ $5	26,666
Archival tags (bigeye)	40% recovery @ $250	7,500
Dart tags (skipjack)	20% recovery @ $5	6,666
Archival tags (skipjack)	20% recovery @ $250	3,750
Dart tags (yellowfin)	30% recovery @ $5	20,000
Archival tags (yellowfin)	30% recovery @ $250	5,625
Lottery	$5,000/year	5,000
ANNUAL COST		**US$1,529,307**
TOTAL COST FOR 3-YEAR PERIOD		**US$4,587,921**

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